Research and Application on Highway Construction Visual Management Information System Based on the Network and GIS

Gong Dejun, Chen Xi, Huang Limang

Highway CAD Institute, Changsha University of Science? Technology, Hunan, China

Guangqing Expressway Ltd., Guangdong, China
(gongdejun@hotmail.com)

Summary

The paper introduced the research and application of the highway construction management information integrated system. Explained the development and application of highway survey applet run on mobile telephone supporting Java and the technique of transmitting engineering data by GPRS wireless network technology. And expounded the development and application of highway engineering construction field data collecting software run on Pocket-PC. Recommended the technique of engineering long distance data transmitting based on C/S structure adopting VPN (Virtual Private Networks) technology. Especially expatiated on the research on the platform of highway construction management information integrated system adopting geography information system (GIS) technique, database technique and network technique. And said all to subsystem about bid manage, contract management, engineering design drawing, engineering survey calculation, measure and pay, data processing on engineering experiment, quantity assessing, project plan and progress, engineering document management etc. Besides? proposed highway construction project visual analysis and inquiry system based on Web-GIS; Explained the research and application of highway engineering construction OA based on B/S structure; real-time workflow and information processing such as the management of administration, business and procedure of authorization and information distribution. At last, the author described the prospect of the application of C/S and B/S structure in trade software development in the highway construction management.

key words

Network; GIS; GPRS; VPN; Web-GIS; OA; The highway construction MIS

1 Introduction

With the infrastructure construction investment enlarging in China for the traffic increasing continuously, the highway traffic construction, especially highway construction, came into vigorous developing period. Beside for new theory, technology, material and technique, the more important thing is requirement in the aspect of management for high grade highway construction than low grade highway construction. Design，bidding，construction? and supervising management are according to the international popular FIDIC contract term so as to reach the aim of clear responsibility , fair competion, strict management high quality and low cost. This need contractor, supervising person and owner to apply advanced means and tool to raise level of management. In highway project construction, it will be the big tendency

of project management to utilize computer system to assist consttruction management. Different engineering software for highway construction have been developed to cater for each section of highway project in our country now. But these software system are developed for different target, independent each other. With the development of computer hardware and software technology, network technology and GIS (geography information system) application, Complicated and comprehensive highway information management system for highway project construction come into being.

Highway construction project scale is huge, construction period length, investment and risk big, participating unit and people much. Success or failure of project rely on corresponding information management level. Visual management system of highway construction is concerned with the plan of overall project, organization, leadship, control and appraisement and so on, including quality control, progress control, cost estimation, and the control and management of cost , material and document and so on. The Highway visual management information system of highway construction need manage and control the whole course of project. The old management system only have static management for personnel files, wages and finance and so on. Dynamic management and control software system deal with plenty of data and information in real time mode to handle , show various charts , store record in project construction course. Application of dynamic project management software give prominence to highway constrction.

2 The GIS and network technique

2.1 The GIS technique

GIS(Geographic Information System) is a kind of information handling and management system, can combination of graph management system with data management system organically, collect and stock for various spatial information, analysis and visual expression.

2.2 Network technique

21 century is the times of information, the times of network. Along with the unceasing development of computer technology and network technology, interconnection network abruptly rise in the sphere of whole world develop quickly. At the same time, the establishment of the network of all trades and professions makes the information become efficient issue channel. Network has permeated all trades and professions. Information highway run more and more information. Official business on internet has become the tendency.

Internet spring-up lead to social and commercial campaign on net. Internet has become a public transmission medium.

However as to VPN (Virtual Private Network) technical, the data of user is passes through ISP in the logic tunnel established in public network. Data is transmitted from point to point in the fictitious special line.

Through corresponding encryption and certification technology, the user's internal network data is transmitted safely on public net, then to realize network data really proprietary. Our management information system adopt VPN technology to carry through project management data at long-range.

The structure of C/S is a kind of software development structure in 1980s. The structure includes two levels of pattern. The show logic and the affair handling are put in client end, data handling logic and database are put in server end. Client end carry out front function, and server end holds conducted backstage support to service. Since the task of customer end is heavier than the task of server, the pattern of C/S is actually "the fat client computer/ thin server" pattern. This kind of pattern is fit for the local area network environment, which is small-scale, user few, unitary database and safety.

Along with the increasing maturation of Web technology, B/S structure based on the Web has become a kind of new technology of replacing the structure of C/S. The structure of B/S is a multiplayer structure of C/S, which was developed from the structure of C/S, and it include: User interface adopts Browers; Network communication rules is TCP/IP; Distribution type computer structure is developed from two layers of unitary to three layers of client, database server and application server composition. The structure of B/S has some characteristics such as economically, maintainability, compatibility, safety, independence and stability.

Network technical and GIS technology has been applied to traffic field widely. But mostly it was only implicated in intelligent traffic (ITS), the maintenance management of highway. Whereas in highway construction management, application system is very few. According to the characteristic of highway construction management, we introduce network technical, GIS technology, make the highway construction management runs visually and in real time mode, make our highway construction management handle official business on net.

3 Data collection system development

3.1 The measure program of mobile telephone (support Java technology) development and the GPRS wireless network data transmission

In course of highway construction , project measure is the one of crucial link of project construction. It will concerns the success of entire project. In highway construction measure, there mainly are level measure, lead measure and construction measure (center line put shape and side stake put shape, the measure of cross section, project progress control measure and structure thing put shape and fulcrum measure, settle to silt measure) etc. What the pattern of handwork task adopts is that the instrument measure of open country and handwork recorded, handwork calculation and export measure harvest. In the course of measure, often cause to measure to make mistakes because of artificial factor as well as other factors, Cause the huge pecuniary loss in project.

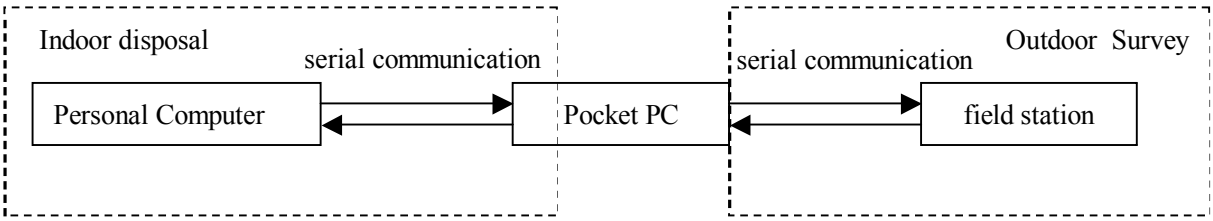
To solve the project measure mistake which was cause artificial factors as well as complex repetitive calculation. In order to Liberate staff from fussy calculation cause, it is important to develop the suitable measure program to solve complex measure calculation.

Because the time of field measure is long, and the requirements of the power consumption ,weight of electronic equipment is high, we use small volume, light weight, supporting java technical, the good operating interface and convenient data transmission mobile telephone with few power consumption to develop measure program, and to realize the

field measurement with electron . Now because many mobile telephones have supported GPRS wireless conected the Internet, data stock and transmit have been solved.

3.2 measure instruments of palmtop computer that suit whole station instrument to carry out project measure highway construction

The measure instrument that highway construction adopts mostly is level and field station. the most field station support serial communication. To stop measure calculation by artificial intervention causes mistake, and to realizes digitalization measure, we use small volume, light weight , large stock, with litlle power consumption , supporing windows-CE development and serial communication to carry out measure work.



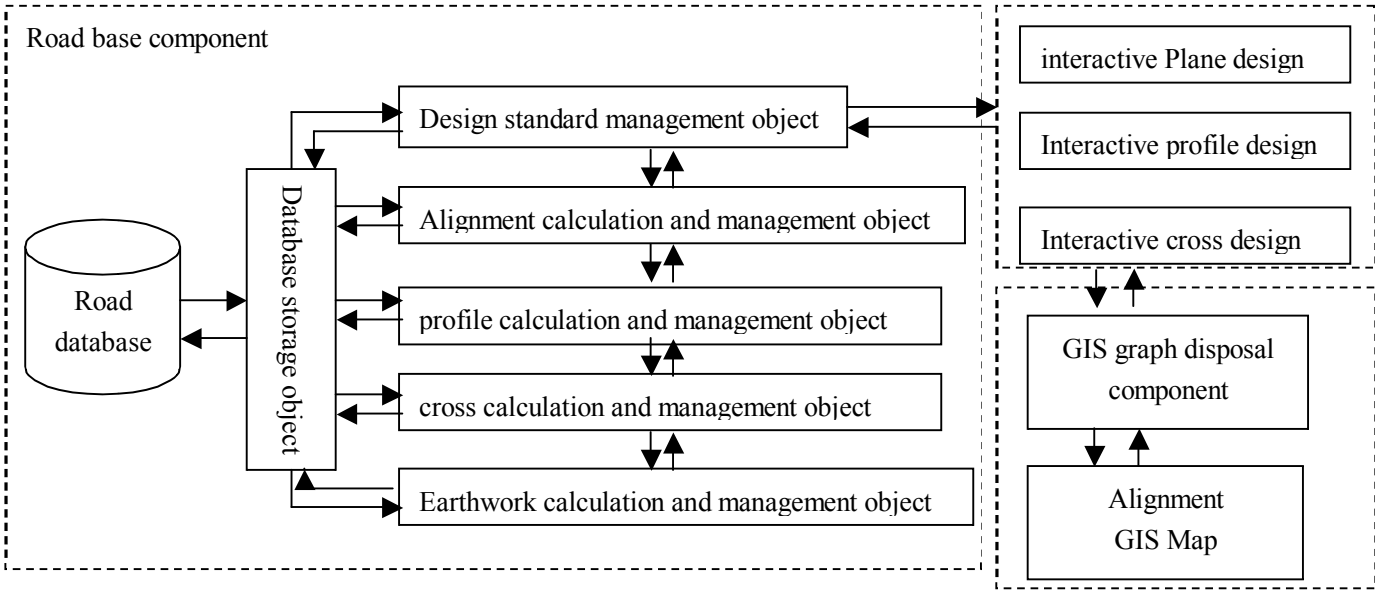
4 Highway GIS visual platform

The establishment of highway construction project visual management platform mainly includes the establishment of route and electronic map of individual projects. Usually, the establishment of geography information systematic electronic map carries out by collecting field data with aerophotogrammetrical survey and digitalization survey and otherwise, digitalizing in home. And the establishment of construction project electronic map, considering the projects of highway construction and the route of highway construction project being danamic building in progress, can only be set up through design program for the of individual projects and route.

4.1 The establishment of route electronic maps of highway construction project

The core of highway construction is plan, profile, cross section design datas. But the traditional management systems ignored these aspects, the management of design data is in a state of confusion, in progress querying of route original design data, as well as project change is very difficulty. To solve this problem, at the same time, programme to establish the electronic map of individual project, we will introduce the content of route CAD that usually applied in design into the management of highway construction project.

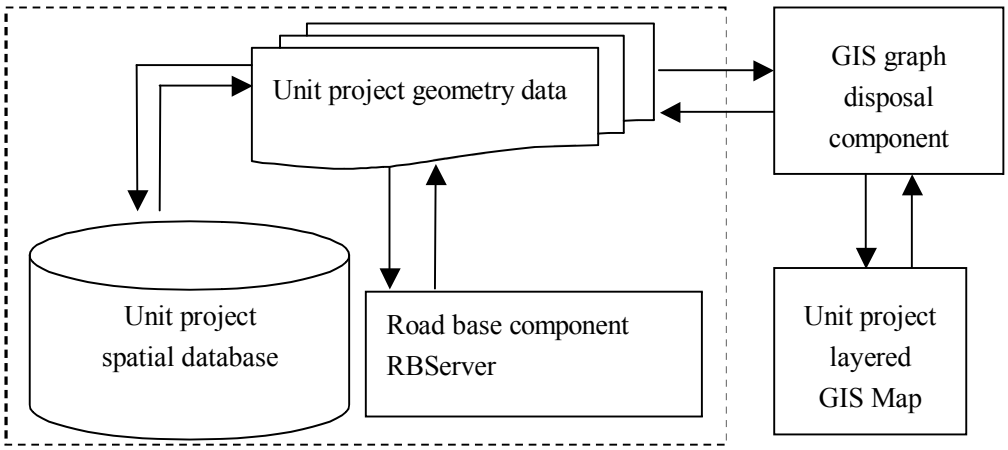
Route plan, profile, cross section design data stored in route foundation compute component RBServer (Road Base Server), through RBServer establishment route design database (static data), at the same time, establish the three-dimensional model of highway. It is layered for the road center line, subgrade, slope foot and slope top line, adopt the graph technology in GIS according to route design information, program to establish the electronic map of route.



4.2 The establishment of individual project electronic maps

Another core of highway construction is construction of individual projects (subgrade, bridge, culvert, separate intersection, passageway, tunnel, drainage, protection and pavement projects etc.). In the management and the construction of project is based on project object come to develop project, so project object can regard to expression in vision is important. The data unification of individual project is managed with database.

Based on central stake or stake scope of individual project and other geometry information, using RBServer to caculate coordinates of graphic elements, we establish the graph of individual project object through GIS graph component.



The GIS graph of route and individual project, route topographic drawing, three-dimensional satellite image, manage department make up of the highway construction electronic map.

The electronic map of entire project is to establish according to contract section, data is kept on Employer's server. The supervision and contractor can download route and individual project data of it's own through VPN from Employer's special network, highway construction visual management platform will be automaticlly created after downloading.

5 The development of the business system based on GIS graph platform

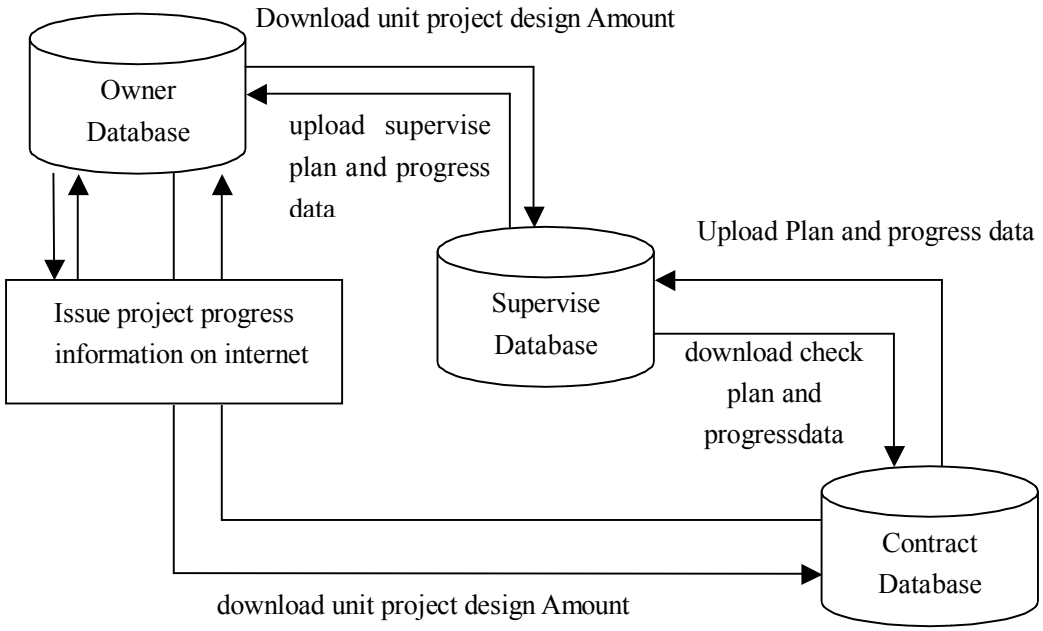
Individual project is the main part of project management (planned progress, examination and detection, quality evaluation, document and information management, design drawing, measurement and payment), all business system development is revolve around it to process business. Individual project has its geometry location (spatial property), is handled through graph with the property of to it related relation

5.1 The management of planned progresses

Project progress control is one of the 3 controls of project management, To solve manager from macroscopic on the progress of control project, Planned progress will be basic with unit project progress control, Realize entire project as well as every major functions such as analysis that mark progress deviation and the collection of actual progress information and the authorized strength of section progress plan, At the same time, can manage to make policy to offer corresponding support information and complete document.

Planned progress data unification is managed on Empolyer's server with database, first through the GIS graph platform that had established hold to control interface authorized strength the design project of individual project vivid structure quantity, establish the individual project account database of entire project, prison is managed, contractor the project of the individual project that downloads the contract section governed or the section of this contract quantity, establish own individual project account database. Empolyer basis project start date and the unification of date of completion establishment the planned progress period of project, Supervision and contractor pass through network to download project-planned period.

Each contractor passes through GIS can regard to melt graph hold to control interface, according to the individual project design project of the contract, measure and plan the annual, quarterly, monthly planned progress data of the progress period section of authorized strength of this contract, on biography go to Supervision unit, by Supervision, unit verifies approval to implement Supervision, pass on monthly magazine to Empolyer.



Project planned progress data transmission is sought along with the progress of project, contractors can inquire the project progress condition of this contract and individual project (project quantity and project investment etc.) through GIS graph platform. Supervisor can carry out plan through the GIS graph platform project progress of inquiring the contract section and individual project governed. Empolyer can go to entire project, each contract section and individual project through GIS graph platform inquiry, plan with actual progress, at the same time through network to the progress information that the public issues project supervisor unit or solicitude the people of project land only to build the website of project for can real time the progress of knowing project.

5.2 Engineering document and file information management

Recently, files management of the highway in our country still stays basically in traditional handwork operating pattern, problems exist in 3 main aspects as follows:

The first is collection of file information. Complete collection is the foundation of files management, files of project include ones from decision, design, construction, completeness of project to quality check, till the future highway operation management, reconstruction and other vocational works; all these files form an organic whole, which lacks any one will affects its integrity. The Ministry of Communication has established detailed highway project files management content in" highway project is completed file material upright roll file management method ", but most of highway project demand large amount of investments, many contractors, and the project itself is most mobile and the schedule is long always. Therefore the most of highway construction project files' quantity is large, is associated with more units, form time span big, professional strong, carrier much shape, on objective, the development that gives the work of highway construction project files brings great difficulty, add again the handwork way that adopts tradition to collect, if have not work not prompt, can cause the construction project files of highway transportation incomplete not whole, is even lost permanently.

The second is arranging files information. Files manager is carrying out the complete foundation of collecting for the file that highway project construction course forms, follows the law that highway construction project file forms, maintains it to have completeness, stage and professional characteristic, classifies and organizes roll and catalogue according to certain principle and method, makes it layout be easy to manage by order. Now, the most highway project construction and management unit are still arranged with handwork way for files information.

The third is taking care of and make use of file information. Taking care of highway construction project files should adopt various effective measure and method (including files guard against thief, fireproof, prevent damp wet, high temperature defense and dustproof, insect-resistant etc. safe measure). Surmount and restrict to harm destroy the factor of highway construction project files, the purpose that reaches complete and safe surely highway construction project files and prolongs its life makes files get more reasonable development and use. Will establish complete files management system, at the same time, still establish complete retrieval tool, otherwise seeking files just like " big sea drag needle ", and files still occupy plenty of house spaces.

In a word, files worker can not satisfy in traditional handwork type to rely on catalog, check number, worker's skill, to reach main points with great efforts or use needs solution what problem, can be accurate to recommend the information for use short-cut, play the role of staff officer actively.

To solve the problems existed in files information management, based on GIS graph platform have developed files management business handling module, on function realization: Document information file and inquire working unification pass through GIS graph object (station and individual project) go on, choose the files belonging to Empolyers, supervisors and contractors, and choose individual project file and design drawing paper etc. and the construction file of individual project; Realize construction project file and construction file (including the document information such as test detection, quality evaluation and measure) , progress control file , measure to pay file, exchange official document and supervisors' file and the paper of design drawing , is completed all document information such as chart, project construction photograph and the information of an image management; Realize : according to unit, branch and minute project inquiry collection inquiry files information, at the same time, can also inquire according to file type collection , can still ask to gather files information according to files; Electronic file type is managed

Can manage the electronic file that includes the kind forms more than 20 such as WORD, EXCEL, PowerPoint, AutoCAD, PDF, TXT, picture, sound kind and video kind , under the tight control of limits of authority , user can put and play as electronic file moves and shrinks , modifies , derivation , print etc. operation.

5.3 Bid management

Highway construction projects now adopt the way of entering a bid carry out public competition, to ensure the bidding is fair and reasonable, reduce artificial factor intervention to the work of entering a bid, this partial contents are major to study and develop the list of project volume, bid and offered price management and bid appraisal management.

5.4 Contract management

Contract management module major research and develop project start to apply for / examine and approve; Project change management, including the modify application and the modify written reply management; Break promise and claim damage management , including break promise of delay time, cost claim; Price is adjusted; Bonus management, include being completed in advance the management of bonus etc.; Contract warning function makes you know in advance the contract that will soon come into effect or finish.

5.5 Measurement and payment

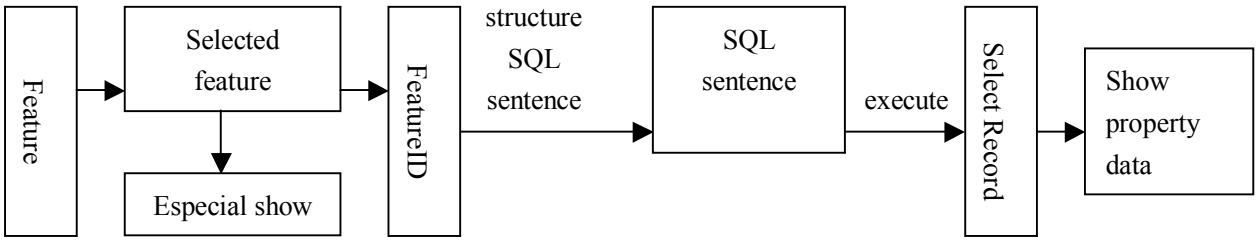
The major research and development of measurement and payment module: Combine project practice, introduce the concept of project account, through the project account reflect every payment project now payment condition, surplus project volume and realize the control of amount for each payment project. Through network or floppy disk, allow construction unit to appear in newspaper to measurement and payment report data and supervise unit send out measurement and payment verification data; It is accurate, prompt voluntarily generation highway project project requirement measure to pay series form.

5.6 Structural analysis and inquiry based on the C/S

project information inquiry is one of focal points in daily work, for each department can understand the various informations of project in time, this modular develops based on the structure of C/S, can regard to melt graph platform spatial information and property information share , through GIS graph for resembling inquiry property data, through property data inquiry corresponding graph element.

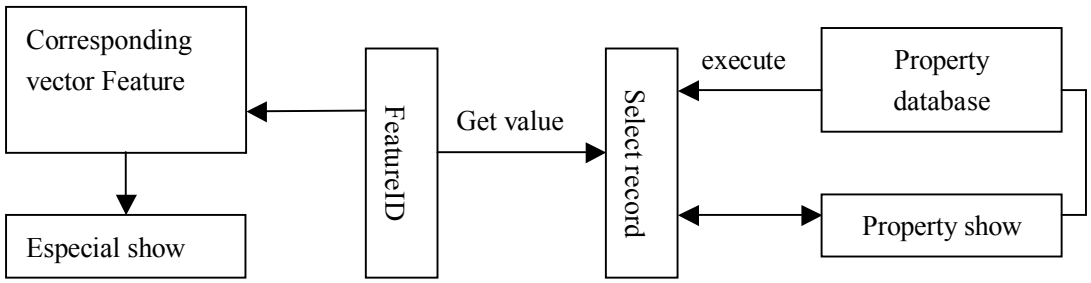
(1) Inquiry from vector graph to property

The inquiry from graph to property, through following course realizing , selecting graph element, geting the identification of the graph element that choose , according to identification yard, joining corresponding database and construct SQL inquire sentence, then in database partially conducted SQL sentence, return inquiry result, transmit property area show.



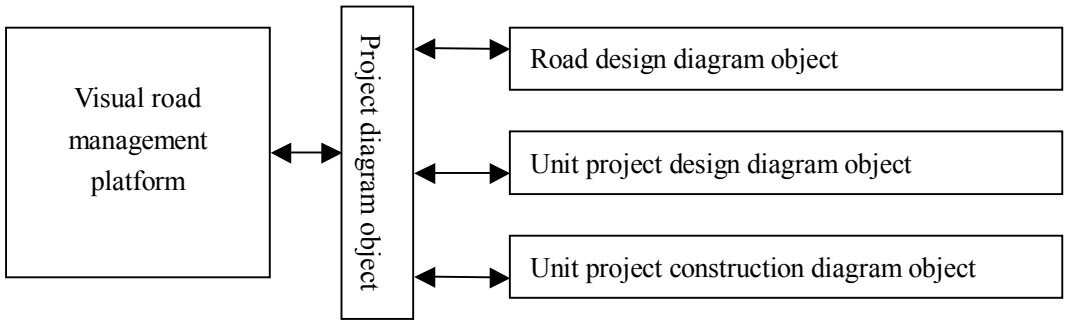
(2) Inquiry from property to vectors graph

the inquiry that goes to graph by property is the countrary course that vector the graph goes to property inquiry. Its basic course is as follows::



5. 6. 1 The Drawing of Engineering works

In the course of establishing in GIS electronic map platform has established the space database of route , and at the same time it also has established the design data database of individual project. Therefore according to the needs of project, we can develop the table of design drawing of chart and export the route modular and individual project. According to project progress control measure data and the progress data of project, we can export the shelf of progress schedule with the middle of the graph of cross section. the study has developed project test detection and quality evaluation project form export modular.



To inquire the number of route arbitrary stake Zong from the graph platform and the shape of cross section of design drawing and the graph of vertical section in the design information as well as export stake scope of cross section. The design drawing that selects individual project to draw individual project is shown and project as well as the construction chart in project construction course is completed chart.

5.6.2 Quantity calculation

The quantity of the calculation major reflection in the roadbed design project of cubic meter of earth and the stone of roadbed project of cubic meter of earth and the stone in quantity and construction, the course in calculation of quantity, the design of a project is measured in the establishment of platform, to install the proportion of cubic meter of earth and stone, to route project basic parts the RBServer roadbed project of cubic meter of earth and stone that calculates stake scope voluntarily quantity.

5.6.3 Static information inquiry

- Visual inquire individual project geometry information;
- Visual inquire the project of cubic meter of earth and stone in route arbitrary stake scope;
- Visual inquire project investment information and each contract section project, measure and invest in information and the information of major project;
- Visual inquire project geological information;
- Visual inquire the structure paper of design drawing.

5.6.4 Dynamic information inquiry

- Visual inquire the route wantonly stake construction course information of cross section (fill to dig altitude , fill to dig area);
- Visual inquire unit and branch , divides into project document information (the paper of design drawing, test information, quality evaluation file, construction photograph and an image information etc.);
- Visual inquire the document information owned in arbitrary scope from graph;
- Visual inquire project change information;
- Visual inquire unit project vividly progress condition;
- Visual inquire contract section project progress (project quantity progress and investment progress);
- Visual inquire prison, manage unit to govern the project progress condition of contract section (project quantity progress and investment progress);
- Empolyer can regard to melt to inquire the project progress of entire project and each contract section;
- expresses the roadbed project progress condition of cubic meter of earth and stone with ground line image;

- route Zong, cross section is completed chart inquiry with draw.

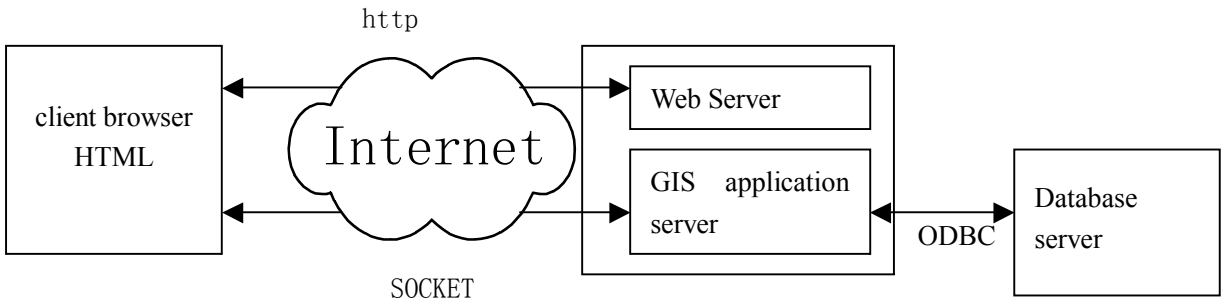
5.6.5 Visual analysis and inquiry based on Web-GIS

Along with the unceasing development of network technology with people the demand for geography information system (GIS), issue and publish space data using network on Web , offer space data for user the function that glances over, inquires and analyses , have become the inevitable tendency of GIS development.

The dimension net geography information system of ten thousands (Web-GIS) is in Internet or Intranet network environment under a kind of compatible , stock and handle , analysis and the computer information system that shows and applies geography information. Is a new technology that develops in last few years, have gotten application in a lot of fields. In highway construction project management a lot of information and situation (as: Route, individual project and station etc.) is related. Ask to need business property data and space data 11 land in correspondence with connect, and can realize the management for business data according to the correlation of space location. Obviously under this kind of condition, it is more visual than showing with figure and writing to show with graph with image.

Now used in the platform of Web-GIS development, various, this system adopts MapXtreme of Mapinfo company develop.

Nowdays the platform used in Web-GIS development is various, this system adopts MapXtreme which is developed by Mapinfo company.



(work principle of MapXtreme)

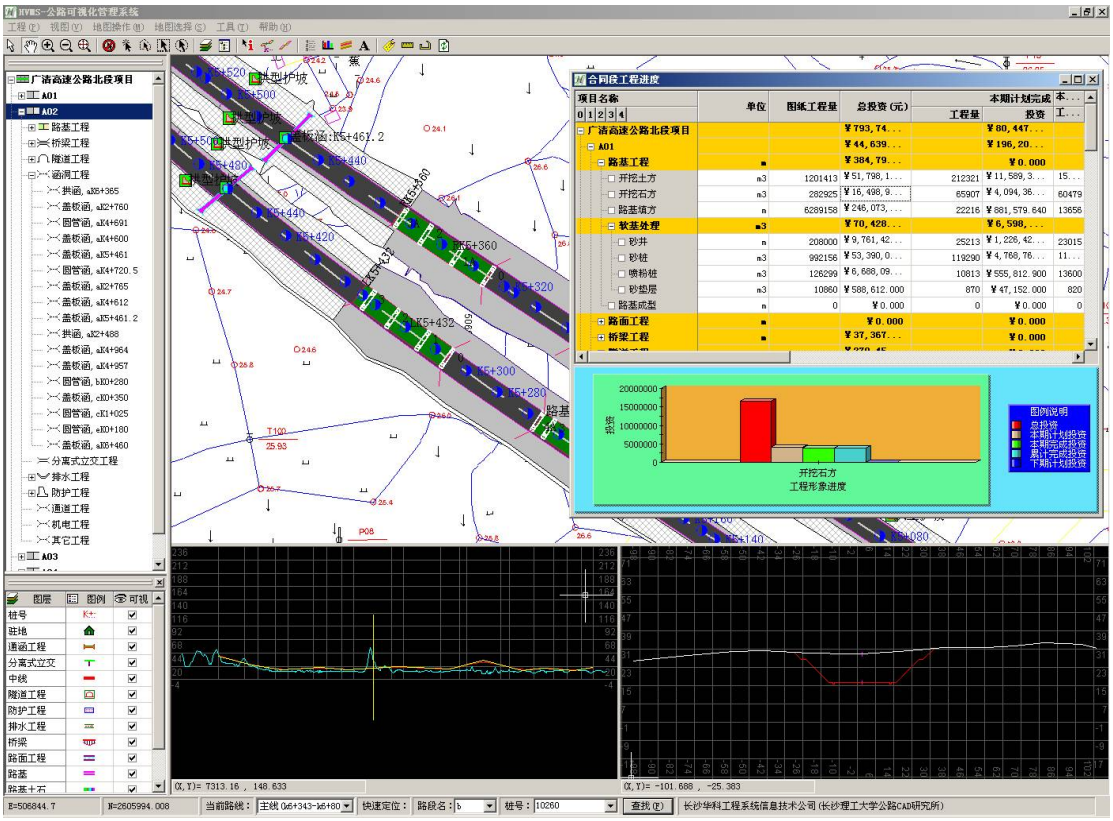
Its working principle is as follows: Browser dispatch HTTP request to Web server, and Web server responds the request of client computer, and then returns the HTML page of request surface. GIS assembly is used to accept user request, to carry out some basic space data manipulations , through SOCKET and the GIS application server communication of application logic layer to submit request and get data; GIS application server receive the application request of client computer, and then ,according to application logic, Will ask transformation number to ask to be rear according to storehouse

Through ODBC and database server interactive, it delivers handle results to client computer application program.

The analysis and inquiry way of Web-GIS are the same as C/S's.

6 Conclusion

Highway construction visible management system, which is visual engineering management software platform, is based on the actual needs of the Guangqing freeway project, by use of modern popular GIS technical, network technology and database technical development. It concentrates on the developing comprehensive information management method in the highway project construction course. Data such as route design data and individual project design data (planned progress information, picture writing and information, test detection and the assessment information of quality inspection) is in one body and use each other. It has offered effective evidence and means for the macroscopic management of the project, has raised the level of project management. Highway construction management system and project OA integration based on GIS graph platform will be a new direction of the engineering project management system research.



（Visual Highway Information Management Based on GIS and Internet by Highway CAD Institute）